

Humanoid Gesture Controlled Excavator Arm

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ABSTRACT

It is difficult for those without experience to operate and manipulate a mechanical excavator. There is a long learning processes to gain the skills required in operating the excavator's overall swing motion as well as movement of its boom, arm and buckets. In addition it is dangerous to operate such excavator on an inclined plane as this can lead to instability and put the operator at great risk. Here we propose a simple light weight sensors operated system which has been developed for the excavator for dealing with these problems. Three sensors are attached to the operators arm in order to detect his movement. The operation commands for the actuators of an excavator will transmitted via wire communication method. The operating system to operate the excavator easily and safely is developed and the control algorithm verified by tests.

Keyword: Excavator, Potentiometer, Servomotor.

1. INTRODUCTION

An excavator is a machine for digging, material handling, demolition, general grading and mining. Excavators can be divided into two groups, namely large sized and small sized machines. Untrained operators such as farmers and less skilled engineers frequently operate small sized excavators without a license, although full trained and licensed persons and skilled operators are allowed to operate large sized excavators. The small sized excavators can be used in a small farm, an orchard and an urban alleyway. In such working conditions, tele-operation systems can be more useful in a small sized excavator and previous studies have focused on developing an unmanned excavator because of this and also for safety reasons .Moreover, when users and owners of small excavators are not proficient operators, it can be a difficult and long process to master the skills required.

The operator manipulates an excavator directly by using two joysticks. However, unskilled operators require a long period of training in order to gain the necessary experience and to understand the correlations between the movement of the excavator and control of the joysticks. In view of these issues beginners have lots of trouble in becoming proficient excavator operators. What is more difficult is to detect a load exerted on the tip of the bucket and the operator has to estimate this from other feedback from the machine; these can include aspects such as how fast the bucket is moving, the load being carried from the engine's response and the resistance from the joysticks.

2. INTERACTION WITH MACHINE

Keyboard and mouse now provide the means of virtually all input. Use of other options than mouse or keyboard i.e. grasping virtual objects, hand, head or body gesture, eye fixation tracking are becoming popular with popularity of ubiquitous and ambient devices like digital TV, play stations. We will see more elderly people and fewer younger people as a process of huge demographic change. The older population will continue to grow significantly in the future. It is widely accepted that we need to address this issue through more research work.

This paper investigates the research works of gesture controlled technology for user interactions. About 30 years of research studies have been listed here. Gesture type, use of different parts of the body, gesture commands, chronological evolution, gesture application, interface, technology, user type, issues addressed, tasks and final result have been listed and described to give the background of gesture based technology development. After analyzing what we have done, this paper describes next options of GCUI.

3. EXISTING SYSTEM

3.1 EXCAVATOR ARM



Fig 3.1 Excavator degrees of freedom

It gives an overview of the desired target excavator and illustrates its degrees of freedom. The system has only four degrees of freedom namely, swing, boom, arm and bucket motion. The coordinate system of the excavator and the operator has been determined and can be seen in Figure. The origin of the coordinate systems (X, Y, Z) of the human body is on the shoulder. The X-axis faces the front, the Z-axis is skyward and the Y-axis is to the left side.

The coordinates on the hand (x' , y' , z') are also shown in figure. The origin of the coordinates of the excavator is at the centre of a swing bearing with the direction of each axis being the same as those on the operator.

3.2 CONSTRUCTION OF EXCAVATORS

In schematic drawing of a typical excavator under consideration is shown. It consists of a chain track and the hydraulic propel drive which is used to manoeuvre the machine but usually not during a work cycle.

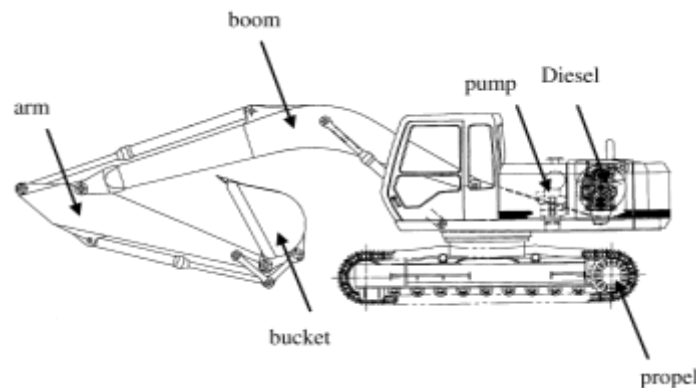


Fig 3.2: Schematic drawing of a typical excavator

On top of that is a carriage where the operator is sitting. It can rotate around a vertical axis with respect to the chain track. It also holds the Diesel engine, the hydraulic pumps and control system. Furthermore, there is a boom, an arm and at the end a bucket which is attached via a planar kinematic loop to the arm. Boom, arm and bucket can be rotated by the appropriate cylinders. The required pressures in the cylinders depend on the position. For the “stretched” situation the pressure in the boom cylinder is 60% higher than in the retracted position. Not only the position but also the movements have to be taken into account. Situation where the arm hangs down. If the carriage does not rotate there is a pulling force required in the cylinder. When rotating – excavators can typically rotate with up to 12 revolutions per minute – the force in the arm cylinder changes its sign and now a pushing force is needed. This change is very significant because now the “active” chamber of the cylinder switches and that must be taken into account by the control system. Both figures demonstrate that a simulation model must take into account the couplings between the four degrees of freedom this excavator has. A simpler model that uses a constant load for each cylinder and the swivel drive leads to erroneous results.

4. PROPOSED SYSTEM

It is difficult for those without experience to operate and manipulate a mechanical excavator. There is a long learning process to gain the skills required in operating the excavator’s overall swing motion as well as movement of its boom,

arm and buckets. In addition it is dangerous to operate such excavator on an inclined plane as this can lead to instability and put the operator at great risk. Here we propose a rotary potentiometer operated system which has been developed for the excavator for dealing with these problems. Two potentiometer and a push button are attached to the operators arm in order to detect his movement. The operation commands for the actuators of an excavator will transmitted via wire communication method.

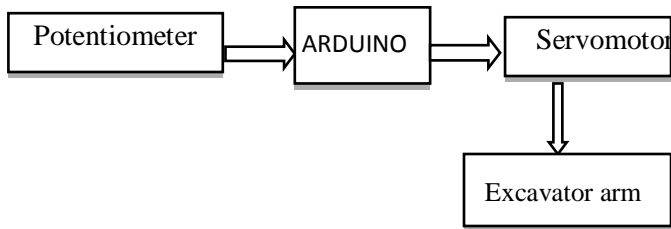


Fig 4.1: Block Diagram

5. HAND GESTURE CONTROL

This HAND GESTURE control of the Excavator arm is facilitated through the design of hand gesture control kit by arranging two potentiometers on the joint of the arms. Here by detecting the motion of the hand in terms of angular movement of the joints of the hand by using two potentiometers on two joints. For controlling the Bucket motion the push buttons are used because the movement of wrist have higher degrees of freedom and its movements are difficult considering ergonomics push buttons are used. The push buttons are activated via thumb press. On hand joint movements the potentiometer knob are rotated varying the resistance of the potentiometer which are detected by the Arduino mega 2560 board input terminals. By burning suitable embedded C program in Arduino mega the input from the potentiometer are used to control Servo motors proportionally. The push button input is in the form of ON and OFF state by detecting it using Arduino, the bucket motion is controlled by servo motors by the program. The swing motion of the Arm is controlled two push buttons which on activation performs clockwise and anticlockwise rotation of the DC motor using Arduino. By coordinating all these inputs the Arduino which can perform multiple tasks using interrupts perform movement of the Excavator arm mimicking the hand movements

6. FABRICATION OF ARM MODEL



Fig 6.1 Arm Control Equipment

In this Arm model the potentiometer knob are rotated varying the resistance of the potentiometer which are detected by the Arduino mega 2560 board input terminals. By burning suitable embedded C program in Arduino mega the input from the potentiometer are used to control Servo motors proportionally. The push button input is in the form of ON and OFF state by detecting it using Arduino, the bucket motion is controlled by servo motors by the program. The swing motion of the Arm is controlled two push buttons which on activation performs clockwise and anticlockwise rotation of the DC motor using Arduino. By coordinating all these inputs the Arduino which can perform multiple tasks using interrupts perform movement of the Excavator arm mimicking the hand movements.

7. DESIGN MODEL

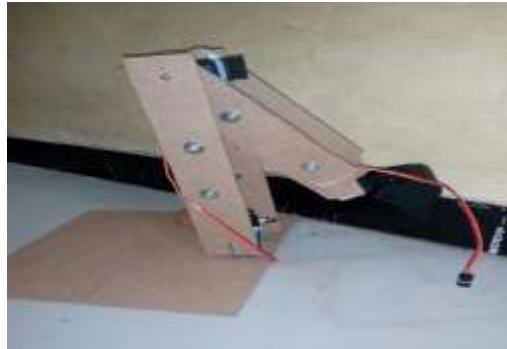


Fig 7.1 Excavator arm model



Fig 7.2 Arm control Equipment

8. FUTURE ENHANCEMENT

8.1. USING ACCELEROMETERS

In today's world there is an increasing need to create artificial arms for different inhuman. Situations where human interaction is difficult or impossible. They may involve taking readings from an active volcano to diffusing a bomb. Here we propose to build a robotic arm controlled. by natural human arm movements whose data is acquired through the use of accelerometers. For proper control mechanism and to reduce the amount of noise coming in from the sensors, proper averaging algorithm is used for smoothening the output of the accelerometer. The development of this arm is based on ATmega32 and ATmega640 platform along with a personal computer for signal processing, which will all be interfaced with each other using serial communication. Finally, this prototype of the arm may be expected to overcome the problem such as placing or picking hazardous objects or non-hazardous objects that are far away from the user.

8.2. USING INERTIAL SENSOR

The development of wireless sensing control unit operation is base on wearable inertial sensors. Inertial sensors are of tri axial accelerometer and MEMS. It extends to the control of an anthropomorphic robotic arm. Accelerometers used to measure the orientation and angular velocity of the lower arm. The data processing has been carried out on low cost micro controllers. The movement of the user arm was mimicked by the anthropomorphic robotic arm. The orientation of the control unit is tracked and displayed using MATLAB. Applications include industrial operation, remote operation in hazardous area, medicine and undersea recovery.

CONCLUSION

Whatever comes in our mind when we think about the excavator that they are very difficult to operate and another one is we can't get the full body clearance of the bulldozer .In order to reduce the difficulty and rectify this problem and controlling the arm of excavator using human arm. In this method there is no need of the skilled labor once we observe it is

easy to operate. Although in the two arms are not enough to operate the lever at the same time .So it is takes some time to operate levers one by one of the arm Motion .But in our method the time will be saved because of the controlling motion in one arm .The another hand will be free so, we can stay any other operation like vehicle motion in the future enhancement .We are operating it now with wired method using potentiometer .But our idea for future is the wireless techniques using “Wi-Fi or Bluetooth”. Our aim is to reduce the cost and difficulty we use the potentiometer as sensor .By the rotation of potentiometer make the arm of excavator to move respectively. By this setup the cost will be reduced but the accuracy will be lenient. The operation shows that is easy to operate the excavator arm because it is not difficult by it is looking.

REFERENCES

- [1]. Dongmok Kima, Jongwon Kima, Kyouhee Leea, Cheolgyu Parkb, Jinsuk Songb, Deuksoo Kanga,-Excavator tele-operation system using a human arm Automation in Construction Volume 18, Issue 2, March 2009, Pages 173–182
- [2]. Robotic Arm Control Through Human Arm Movement Using Accelerometers-(Ashutosh Pattnaik, Rajiv Ranjan)-Department Of Electronics & Instrumentation Engineering, National Institute Of Technology
- [3]. N. Nandhini, SU. Suganthi Wireless Control Of A Robotic Arm Using Inertial Sensor International Journal of Engineering and Advanced Technology (IJEAT)ISSN: 2249 –8958,Volume-2, Issue-4, April 2013
- [4]. Shamsheer Verma Hand Gestures Remote Controlled Robotic Arm Advance in Electronic and Electric Engineering. ISSN 2231-1297, Volume 3, Number 5 (2013), pp. 601-606 © Research India Publications <http://www.ripublication.com/aeee.htm>
- [5]. Huiyu Zhou, Huosheng Hu, Reducing drifts in the inertial measurements of wrist and elbow positions. IEEE Trans vol.59,no.3 (2010)
- [6]. Tao Liu *, Yoshio Inoue, Kyoko Shibata,“Development of a wearable sensor system for quantitative gait analysis”. Journal (2009) 978-988
- [7]. Mayank J. Patel, Brijesh N. Shah” Robotic Arm Movement Using Image Processing “ International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-4 Issue-2, May 2015
- [8]. Mohammed Ashiq Kamaril Yusoffa, Reza EzuanSaminb, Babul Salam Kader Ibrahimc, “Wireless Mobile Robotic Arm”, International Symposium on Robotics and Intelligent Sensors 2012(IRIS 2012), July 2012.